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Infrared Hand Vein Detection System

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ABSTRACT*: In any surgery, the first important phase is an insertion of an intravenous (IV) catheter. The major problem face by the physicians is difficulty in accessing vein for IV drug delivery or taking blood samples for test. In case of children, adults, critical care patients etc. It is very difficult task. Unnecessary puncturing of veins occurs due to poor visibility. Wrong puncturing may leads many problems such as bruises or permanently damage the vein. To overcome from these problems there is a need of vein detection system. The paper presents an approach for Infrared Vein detection System. In the proposed work Infrared radiation is used to identify the veins appears on the back of the hands and Smartphone camera is used to capture the images. The preprocessing is done to enhance the vein image using MATLAB 2009 of version 7.9.0. The two key characteristics of this device discussed in the paper are portability and low cost.*

Keywords *- Biometric, vein recognition, Adaptive Histogram Equalization.*

I. INTRODUCTION

There are lots of challenges to be found in the design and implementation. Very few devices on infrared radiation have been implemented. In any clinic, hospital or pathology laboratory it is commonly observe that the veins of patients are difficult to detect by the physicians properly, unnecessary of puncturing may occurs which leads to the problem such as swelling, bleeding or may permanently damage the veins. To overcome these problems there is a device like Acuuvein Vein Viewer comes up but the problem is cost and portability factor [1]. The vein pattern is not observable under the visible light. The vein pattern can be detected with help of infrared sensors. There are two different techniques are discussed in paper [3] about the imaging techniques such as far infrared imaging technique (FIR) and near infrared imaging technique (NIR). FAR works within the range of 8-14μm to capture the large veins on the back of the hand, but it sensitive to the ambient condition and does not provide stable image quality.NIR imaging works within the range of 700-1000nm and provide good quality images. There is a medical spectral window from 700 to 900nm in which the light is penetrates into biological tissues up to 3mm of dept, and it allows to non-invasive investigation. These non invasive techniques also help in the treatment of varicose veins, deep vein thrombosis and vascular ailments [4].

1.1 NEEDS FOR VEIN DETECTION

- Intravenous injections: For giving medicines and drugs to the patients, intra- venous injections are given by doctors and nurses.
- Bruises and Bums: In case of vein diseases like Deep Vein Thrombosis and Varicose Veins, bruises appear on the skin, therefore for the treatment of these diseases, detection of veins is highly essential. Accidents involving first or second degree of bums cause the scarring of the skin. Here appearance of the skin becomes deterred causing the skin to appear whiter or in certain cases darker. The determinations of veins become tough in such cases as well.
- Blood transfusions: It is a process in which blood is given to the person intravenously. Blood donation, kidney dialysis also need perfect vein detection.
- Among children: Locating veins in young children and infants may be especially difficult and having to puncture them several times with a needle is very frightful and agonizing for the child.
- Geriatrics: Many elderly people often require numerous blood tests or medicinal injections and an efficient means of puncture would reduce excessive bruise and enhance the patients overall comfort level [1].

In this paper an approach is presented for vein detection system using Infrared radiation and Smartphone. In the proposed work there are IR LED Ring is used for the illumination and Smartphone is used for capturing the vein image. The captured images are preprocessed to enhance the image adaptive histogram equalization technique is used. Image segmentation is performed to identify the veins.

The rest of the paper is organized is as follows. Near Infrared imaging is introduced in section 2. An overview of proposed system is introduced in section 3. Image acquisition and the pre-processing steps are given in section 4. The Experimental results are presented in section 5. Finally the concluding remarks are given in section 6.

1.2 NEAR INFRARED IMAGING

The special attributes of Near-Infrared imaging which makes it suitable for vein detection are:

- NIR can penetrate into the biological tissue up to 3mm of depth, [4].
- The reduced haemoglobin in venous blood absorbs more of this infrared radiation than the surrounding tissue,

Human eyes can only detect visible light that occupies a very narrow band (400 - 700nm) of the entire electromagnetic spectrum [9]. However, there is much more information contained in other bands of the electromagnetic spectrum rejected by the objects of interest. For human vein patterns on the periphery, the visibility under normal visible light conditions is very low. However, this can be resolved by using Near-Infrared imaging techniques.

Therefore, by exposing desired body part with the infrared radiation of specific wavelength, the vein image can be captured by a Smartphone camera (camera used in our system is as shown in Fig.2). In the resulting image, the veins appear darker than the surrounding tissue, biologically; there is a medical spectral window which extends approximately from about 700 to 900 nm as shown in Fig. 1, where light in this spectral window penetrates deeply into tissues, thus allowing non-invasive investigation.

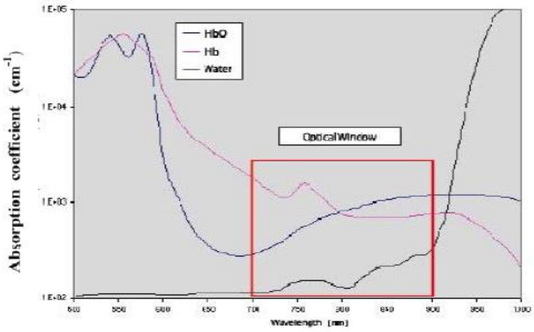


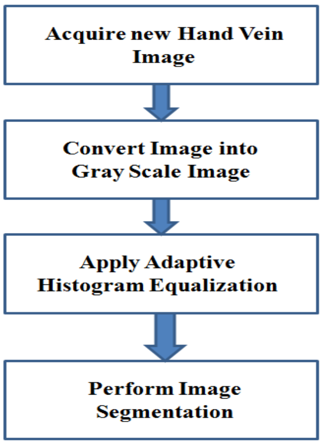
Figure 1 Optical windows for detecting vein patterns [9]

II. OVERVIEW OF THE SYSTEM

Our acquisition system (Fig. 2) is composed of a Smartphone camera with NIR ring of LEDs is used for illuminating the desired body part with infrared light. In this proposed system the Smartphone camera having a resolution of 6MP with 480*640 dimensions is used. The IR LED ring used for illumination is having the wavelength of 850nm. There are 36 IR LED's are mounted on the ring. First the image is captured using mobile camera and then it is transferred to the laptop via USB cable for further pre-processing. Fig 2 shows the device setup used for vein detection.

Figure 2 Hardware system and IR LED ring used for illumination.

2.1 ALGORITHM



The algorithm of the image processing is as shown above And the details of each step is as follows

2.2 IMAGE ACQUISTION

Fig 3 shows the example of captured vein images using proposed system. The software used for pre-processing is MATLAB 2009 of version 7.9.0.

Figure 3 Example of vein image captured by proposed system

2.3 RGB TO GRAY SCALE CONVERSION

First of all the color image is converted into gray scale image to make image into black and white image. It converts the true color image RGB to the grayscale intensity image by eliminating the hue and saturation information while retaining the luminance. Rgb2gray converts RGB values to grayscale values by forming a weighted sum of the R, G, and B components:

$$0.2989 * R + 0.5870 * G + 0.1140 * B \qquad (1)$$

2.4 SMOOTHING AND NO/SE REMOVAL

The median filter is a simple edge-preserving smoothing filter. It may be applied prior to segmentation in order to reduce the amount of noise in a stack of 2D images. The filter works by sorting pixels covered by NxN mask according to their grey value. The centre pixel is then replaced by the median of these pixels, i.e., the middle entry of the sorted list.

2.5 CONTRAST ENHANCEMENT

The images which contain local regions of low contrast bright or dark regions, global histogram equalization won't work effectively. A modification of histogram equalization called the Adaptive Histogram Equalization can be used on such images for better results. Adaptive histogram equalization works by considering only small regions and based on their local cdf, performs contrast enhancement of those regions.

CLAHE operates on small regions in the image, called tiles, rather than the entire image. Each tile's contrast is enhanced, so that the histogram of the output region approximately matches the histogram specified by the 'Distribution' parameter. The neighboring tiles are then combined using bilinear interpolation to eliminate artificially induced boundaries. The contrast, especially in homogeneous areas, can be limited to avoid amplifying any noise that might be present in the image. Figure 4 shows the image after applying CLAHE to the image.

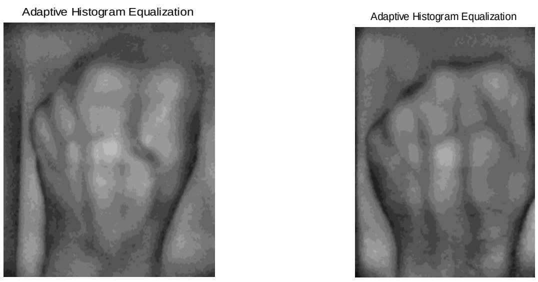


Figure 4 Images After Applying CLAHE

2.6 SEGMENTATION:

Segmentation is the process of thresholding the image. By setting a proper threshold the pixel value above the threshold is set to 1 and below the threshold the pixel will be 0. In this system the threshold is set to 90 by experimentally. Figure 5 shows the image after segmentation.

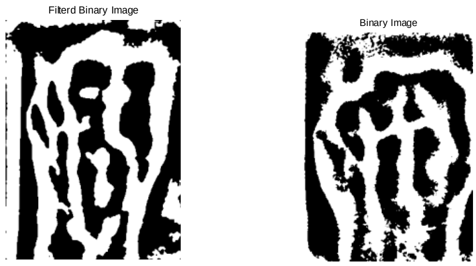


Figure 5 Images after Segmentation

III. EXPERIMENTAL RESULTS

There are different 55 subjects based on gender and age diversity is considered while creating the database as mentioned in table 1.

Table 1 Database of 55 different people

Age	Male	Female
5 – 10 yrs	3	-
20-50	20	15
60-70	2	15

Images are taken by Smartphone camera with 6 Mega pixel resolutions and illuminated with NIR light at a wavelength of 850nm. The vein image is enhanced by adaptive histogram equalization. Adaptive Histogram equalization enhances the equalization. Adaptive Histogram equalization enhance the image in block by block rather enhancing the entire image, while enhancing the image the noise gets introduced in image. To avoid effect of noise contrast limited adaptive histogram equalization is used.

IV. CONCLUSION

Our main goal of obtaining a portable efficient vein imaging system at very low costs accomplished. The proposed system is implemented using available resources therefore the cost of the system is reduced and it is portable. As per the tables provided we have done a pilot study for subjects who include wide range of sex, skin color and age. We have only implemented the acquisition and segmentation of the image which allows for future expansion.

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